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METAMORPHIC AND INTRUSIVE ROCKS OF TYRONE.

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ON THE METAMORPHIC AND INTRUSIVE ROCKS OF TYRONE.[1]

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THE rocks I propose to describe in this paper belong to that great metamorphic series which occupies so large a portion of the north of Ireland, extending over most of the counties Tyrone, Londonderry, and Donegal. For the present I shall confine my observations principally to that portion of them situated about the central parts of Tyrone, from the vicinity of Omagh eastwards and north-eastwards towards Slieve Gallion. This district has been already ably described by General Portlock in his "Geological Report on Londonderry and parts of Tyrone and Fermanagh"; but as, during the progress of my work for the Geological Survey, I have had opportunities for a very detailed examination of it, I beg, briefly, to offer some further remarks and conclusions.

The rocks in the district may be thus classified :—

First.—Schist and Gneiss.

Secondly.—Green metamorphic rock, generally hornblendic or pyroxenic, passing in some parts into schist, and in others into granite.

Thirdly.—Quartz Porphyry and Granite — metamorphic and intrusive.

First.—*Schist and Gneiss.*—Little requires to be noticed of these rocks, as in this district they present but few special characteristics. They occupy a hilly tract of country, extending from near Carrickmore north-eastwards to Fir Mountain, having a width of from three to four miles at the greatest, and terminating at both ends among the green metamorphic rocks presently to be described, in which, indeed, they may be considered as forming a huge lenticular mass. The prevailing character is a coarse massive gneiss passing into schist, generally micaceous, and often containing some hornblende. Close to the junction with the green metamorphic rocks just alluded to, the foliation is less strongly marked, while the texture is more crystalline, and much hornblende appears, as if passing gradually into that rock. Remarkable examples of this may be seen at Fir Mountain, and at Lissan, in the stream forming the county boundary. In the former locality, we find at the base of the hill, micaceous schists and well-foliated gneiss, succeeded by a coarser quality, till at the summit we have massive rocks, in which all traces of foliation seem nearly obliterated, approaching so closely to the hornblendic type that no exact line of division is at all possible. The stream section, north of Lissan demesne, exposes similar rocks, which are more quartzose, and change into granite and syenite. From these observations it would appear that the schistose and amorphous green rocks are but parts of one system, the varieties being due either to differences in the chemical composition of the original rocks, aided, probably, by conditions of greater intensity of heat and pressure, or perhaps, that the more crystalline parts were the result of re-metamorphism. That some such action has taken place over that part of the district at least, I shall endeavour to show subsequently.

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[1] This paper is published by permission of the Director of the Geological Survey of Ireland, and of the Director-General. It was read before the British Association in Dublin, August, 1878.

Secondly.—*Green metamorphic rocks, generally hornblendic or pyroxenic.*—These, as has been remarked, occupy the country around the gneiss series just described. The most prevailing kind consists of an aggregate of plagioclase felspar, which is often labradorite, with hornblende, or pyroxene, or both, developing in some places into largely crystalline hypersthenite, in others becoming more finely crystalline, passing into a compact greenish or bluish variety. Free quartz, too, often occurs, sometimes in grains scarcely perceptible, but in other places developing into great crystalline blebs, converting the rock into a coarse syenite.[1] Examples of this may be observed in the hills north of Pomeroy, where, at the base, the hornblendic rock with a little quartz is seen, which mineral increases in the space of a few yards to great crystals, that weather out in warty excrescences, giving to the rock, as Portlock remarks, "a peculiar mechanical aspect."

In other localities the compact varieties become highly felspathic, and pink felspar (orthoclase) appears, with quartz, until a corase elvanite or quartz porphyry is produced, which usually contains mica and passes into granite, or syenitic granite by the addition of hornblende.

That the green metamorphic rocks thus pass gradually into granite, appears to have been the opinion of the late Sir Richard Griffith and General Portlock. Thus, at p. 60 of his "Geological Report, etc.," we find the latter author quoting the former—"Slieve Gallion mountain is composed of granite, syenitic granite, syenitic greenstone, and greenstone, and the same varieties of rock, apparently graduating into each other, occupy the parishes of Lissan and Kildress"; and at p. 94, he himself states that "there are so many gradations of change, from the rock which appears decidedly granitic into hornblendic rocks on the one hand, and into others which are little more than schists, in which the constituents have been blended together and the stratification obliterated, that the mind seems forced to consider the whole, even to the granite, as metamorphic."

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[1] I use the term syenite in the same sense as it is used in Jukes's Student's Manual of Geology, viz. "A crystalline granular aggregate of felspar, hornblende, and quartz."

In other parts of the green rock basic minerals prevail, and it becomes coarse diorite, diallage, or hypersthenite. One of the best localities where these changes may be seen is at Termon Rock, near Carrickmore. The massive crags which rise abruptly over the flat through which the railway runs are diorites, traversed in every direction by veins of epidote; and at the Glebe of Athenree, one mile to the east, the diorite is replaced by diallage or hypersthenite; while at the "Scalp," two miles to the north-east, a more largely crystalline variety occurs. At all these places the felspar is, as we might expect, labradorite, yet at Oritor, near Cookstown, there is a massive rock in which hypersthene is associated with orthoclase.

In close proximity even to the largely crystalline rocks sudden variations in texture are not uncommon. These are well shown at the locality just mentioned, where, in the same mass, one part is compact, while the rest is crystalline often to a great degree. In some cases, too, hypersthene appears in one part of the mass, while the rest is compact, and traversed by veins consisting of a mixture of quartz and orthoclase. Again, the compact variety often presents the appearance of a dyke traversing the more crystalline portion. In one case of this kind a lenticular dyke-like rock was traced over a distance of thirty yards, and looked very much like basalt. In it, however, white crystals of orthoclase were observed.

These compact dykes and veins traversing the more crystalline portions seem to be analogous to those of fine-grained granite rock which may be seen cutting across the granite in the neighbourhood of Dublin, and have been called *eurites* by the late Professor Jukes. Such veins he regards as portions of the same magma as the granite, proceeding from the parts still in fusion, and forced into cracks or fissures in the partially consolidated upper portions, and the same explanation may answer as well for the compact dyke-like veins just described.

Another variety of these compact and finely-crystalline rocks is one full of cells, usually filled with calcite, or, though rarely, chalcedony. These may be seen at Slieve Gallion, at Drumnakilly near Omagh, and at several intermediate localities. Some parts, from the number and size of the cells, suggesting great disengagement of elastic fluids, present such appearances of a volcanic nature that one is at first inclined to consider them as such, yet, on further examination, there is no evidence of extrusion, the rock changing by the gradual disappearance of the cavities into the ordinary hornblendic close-grained variety.

The passages from these varieties into schistose rocks are also very remarkable. They not only occur in the vicinity of the schist series, but everywhere throughout the mass, no considerable tract of which, indeed, is without some trace of foliation. Thus, at Termon Rock, which is mostly composed of coarse diorite, foliation was observed in the more finely crystalline portions, associated with a variety, which, from its close texture, has much the look of an indurated or highly altered slate, full of strings and ramifying veins of serpentine; and to the north-east of Omagh, west of the road to Mountfield, similar schistoid rocks, also abounding with serpentine, may be seen.

A very interesting series is met with at Beaghbeg, some six miles north of Pomeroy. Here, within a small area, are diallage and quartz-porphyry, having between them finely crystalline and compact rocks. Some of these latter have minute scattered prisms of hornblende in a felspathic-looking base, and change into partially foliated rocks of porcelainic appearance, with numerous strings and veins of quartz. Close to this, on the north-west, are chloritic aud talcose schists, and schist breccias, containing pieces of red iron jasper and green flinty-looking rocks with quartz grains like altered felstones, or perhaps very quartzose grits. These latter were again noticed at Creggan, four miles to the south-west, but among the finely-crystalline hornblendic series. They have all the appearance of metamorphosed conglomerates, and still further confirm the evidence as to the original sedimentary character of these rocks.

Thirdly.—*Quartz, Porphyry, Granite, and Syenite.*—It has been before remarked, that the compact varieties of the green metamorphic rock frequently lose all trace of hornblende, and become felspathic. The base in these cases is usually of a light green or bluish, changing to a pink or reddish grey colour. This occurs very gradually—first there appear a few spots of a pink or reddish shade, these then extend and form the prevailing tint of the base, and some quartz appears. Crystals of flesh-coloured orthoclase and a light olive-green felspar that seems to be oligoclase, are now observed, the blebs of quartz increasing in size and quantity, with an admixture of dark green mica of resinous lustre occurring in hexagonal plates. We thus get a quartz-porphyry—a rock having all the constituents of granite, differing only in the disposition of the silica, which, as just remarked, is in individual crystals, and does not form the base. It is easy to see that a rock of this kind can readily pass into true granite, requiring but such an increase in temperature as to keep the silica in solution while the other minerals have crystallized out, and, accordingly, we find that in many parts of this district the quartz-porphyry does pass into granite. A very remarkable example may be seen at Mullanamore Bridge, north of Carrickmore. The porphyry was observed in the stream a little above the bridge, close to it is a rock which it is impossible to refer with certainty to either class, while immediately at the bridge is typical granite. At all these places the rock has the same general character of a coarse quartzose mass with pink felspar and green mica, except that to the north the base is felspathic, while to the south it is siliceous, and has the granular character of granite. Similar observations were made in a quarry a little east of this, and in some other localities, particularly at Slieve Gallion, where several sections exhibit this change from porphyry into granite.

At the summit of Glenarudden Mountain, the porphyry is succeeded by a rock having a compact base of a greenish or greyish colour, with, occasionally, spots of red or flesh-coloured felspar, and a little diffused hornblende. Towards the north this latter mineral increases in quantity, and quartz appears; giving place, however, to a rock devoid of that mineral, and in which the hornblende is replaced by pyroxene, with some serpentine. This, again, is succeeded by and passes into the same kind of compact felspathic green rock, and ultimately into the porphyry. In the vicinity, at a stream called the White Water, the latter rock has a decided schistose character, approximating it more closely to the nature of a metamorphic than of an intrusive igneous rock.

Another remarkable variety may be seen at Carrickmore, at the Glebe of Athenree, and at some other localities in the adjoining little glen of Tremogue. This is a finely-crystalline mixture of quartz and felspar, with a small proportion of mica, some of which is talcose-looking, though for the most part it occurs in small white silvery scales, probably lepidolite. It is described by Portlock as a granite, though it may perhaps be more properly classed among the elvanites. As the exposures of this rock occur on a regular line bearing north-eastwards, it might at first appear to be an intrusive dyke in the metamorphic rocks, but this view is not borne out by an examination of its relations to those rocks. At the several localities where sections were observed, they seem to graduate into each other, the dark-green micro-crystalline hornblendic rock becoming felspathic and light-coloured, in the vicinity of the elvanite, passing insensibly into it, though in one place it seems to penetrate it as a dyke. It is impossible to say whether the elvanite might not have been originally a bed of fine quartzose grit, or perhaps an intrusive dyke in the old sedimentary rocks, fused in with them when the whole series were metamorphosed.

The granite of this district is very variable in composition. In general, it contains the same minerals as the porphyry, but in some places the mica is replaced by talc or chlorite. Of secondary minerals, carbonate of lime is the most prevalent, and at Limehill, near Pomeroy, it occurs in such quantity, that in one part the quartz altogether disappears, and the resultant is a curious mixture of pink felspar and carbonate of lime; so that it has been burned, though with little success, for agricultural purposes.

Changes from the granite into the green hornblendic rocks, through syenite, have already been noticed. Hornblende, indeed, is pretty generally disseminated through the granite, and in some parts is in about equal proportion with the mica, forming hornblendic or syenitic granite. This again passes into a variety devoid of mica, the felspar changing to a greenish colour, and ultimately into the quartzless hornblendic rock. These changes, as before mentioned, are well seen at Slieve Gallion, and also at the hills called Bardahessiagh, and Craighballyharky, north of Pomeroy, where instances occur, in which the granitic and hornblendic varieties are so blended in the same rock-mass, that it is quite impossible to distinguish them.

Granite as an Eruptive Rock.—When the maximum of metamorphism is reached in the complete fusion of rock and conversion into crystalline granite, we may expect to find that at some places such a mass has been intrusive, and, accordingly, there are few areas occupied by metamorphic granite, in which it has not been evidently intrusive at some parts. Thus, in the granite of Newry, the great mass of which I believe to be of metamorphic origin, parts are certainly intrusive, instances of which will be found detailed in the Geological Survey Memoirs descriptive of that part of the country So, in this district too, the granite has all the appearance of having been intrusive at some parts. Thus, at Drumduff, near Beragh, close to the margin of that rock, the sandstones are indurated, and have an unusually high dip ; but by far the best evidence is to be seen at Aghnagreggan Bridge, near Carrickmore. There the sandstones can be observed in actual contact with the granite, they are highly disturbed and semi-vitrified, being converted into yellowish quartzite, leaving little room for doubt but that the granite has been intruded through them. It cannot be regarded as being due to metamorphism of the sandstone, for in the immediate vicinity beds were found quite unaltered. This could not be the case if this part of the Old Red Sandstone had undergone so complete a change as a conversion into granite. A great extent of rock would be indurated, then foliated and altered into coarse gneiss, which, becoming more massive and crystalline, would ultimately pass into granite. As no such gradation was anywhere observed in this district, no change in the sandstones being effected, except on those in contact, which, as just now remarked, have been partially vitrified and altered in colour, as happens where masses of molten rock have been protruded through sedimentary strata, we may justly conclude that a similar action has taken place here, and that some of the granite has been intrusive. If this be so, then, we have proof that the granite is newer than the earlier part of the Old Red Sandstone period, while the mass of the schists and other metamorphic rocks with which it is associated, and into which it appears to graduate, are certainly older, being probably of Lower Silurian age, coeval with those in the West of Ireland. This apparent difficulty is, however, easily explained, if we suppose the granite, and perhaps some of the other highly crystalline rocks, to be the result of re-metamorphism. The depression, which took place during the period when the great series of sandstones and conglomerates—which even now have a thickness of upwards of 10,000 feet—were deposited, must have sunk the underlying metamorphic rocks to such an immense depth that their lowest portions were completely fused and became intrusive. This latter action must have taken place prior to the commencement of the Carboniferous period, as, at Slieve Gallion, the basal beds of that formation rest upon the granite, and are, in fact, almost altogether made up of its *débris.*

That metamorphic action continued to affect the rocks of this district at various periods up to that of the Upper Old Red Sandstone, seems to have been the opinion of General Portlock, and he regards the granite as a result of the metamorphism of rocks of the latter formation. Indeed, if his view be correct, the formation of the granite should be regarded as of post-Carboniferous age, as it is really the lowest beds of that formation—the red sandstones and quartzose conglomerates—that he calls Upper Old Red Sandstone. The sections he describes at Slieve Gallion, as exhibiting changes from red sandstone through partially altered rocks containing felspar, into granite, have been just referred to, and it has been shown that these appearances are due to the fact, that the sandstones in proximity to the granite are almost altogether made up of its fragments, in many cases, too, of crystals that have undergone but slight attrition, so that the distinction between the crystalline and the derivate rock is often a matter of considerable difficulty.

On the whole, therefore, there appear to be good grounds to establish the conclusion, that we have in Ireland an intrusive granite of Old Red Sandstone age. Hitherto most of the granite of this country has been considered to be of older date except that of Mourne and the elvanites of Carlingford, which are post-Carboniferous.[1] The discovery of granite of an intermediate period is, however, but what we might expect, as we have no reason to suppose but that it was formed during every period, even at the present day, when, as Professor Jukes remarks—"Granite must be forming now wherever molten rock of the proper chemical composition is cooling under the requisite physical conditions;" and we may expect that the further investigation is extended, the better will we be able to assign to their respective ages in the history of our earth, a class of rocks, which, not very long since, were believed to be essentially primeval and antecedent to all others.

Note.—Since the above was written, Mr. Kinahan's book on the "Geology of Ireland" has appeared, in which the rocks here described as Old Red Sandstone are classed with the Silurian system. Without expressing any opinion on this question, I may remark that it does not at all alter the geological position of these beds, as they are referred to a later age than any of the generally recognized Upper Silurian rocks—while the era of intrusion of the granite must still be regarded as of post-Silurian and pre-Carboniferous age.

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[1] Mr. Symes describes an intrusive granite near Westport as "of older date than the Upper Silurian period," but there does not seem to be any evidence to fix its age more definitely. See Geol. Survey Memoir to accompany Sheets 83 and 84.

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